Iron and Magnetic Design for Low Field VLHC Magnets

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VLHC Magnet Technologies

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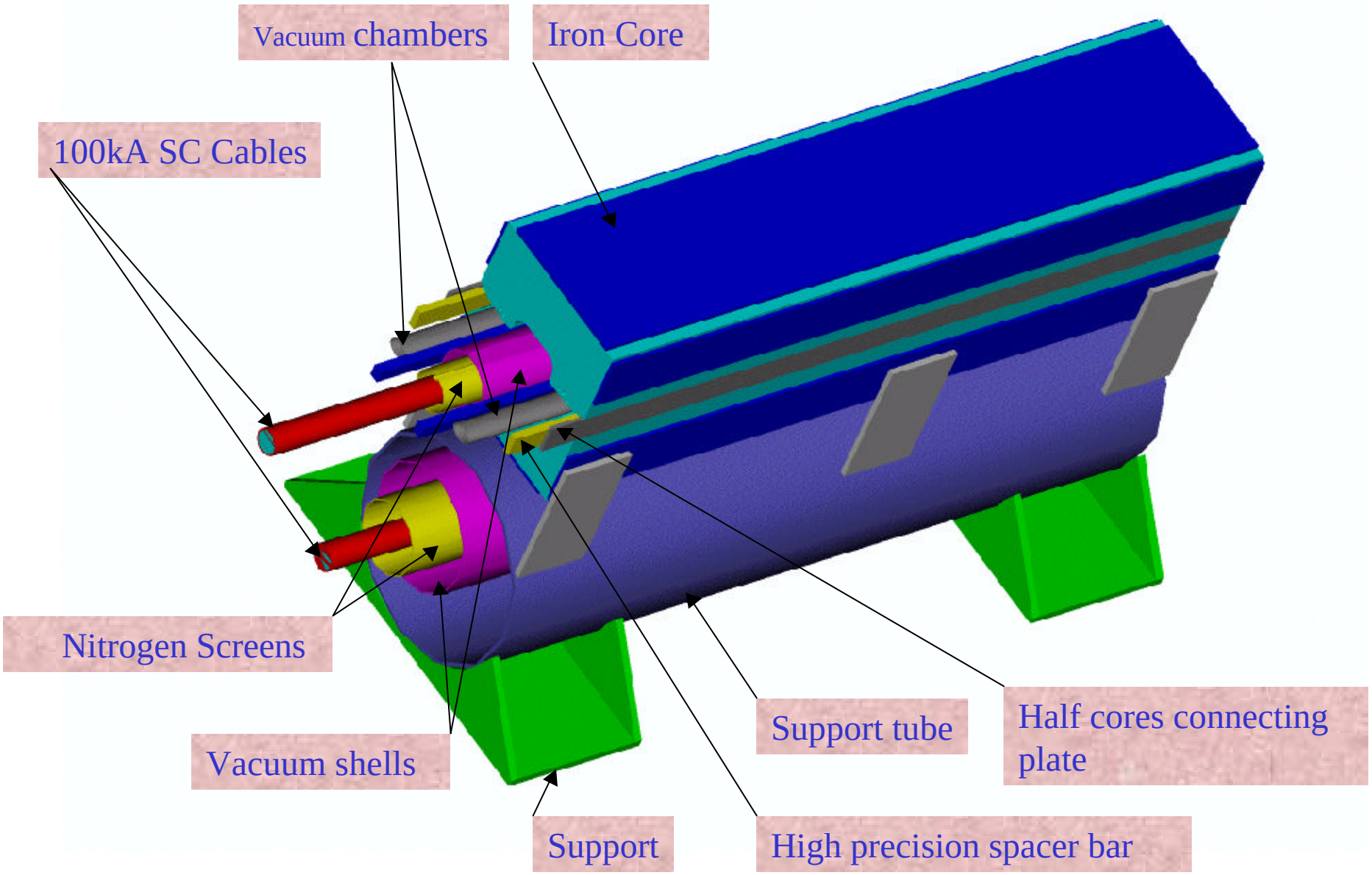
Design of a 2 Tesla Superconducting Transmission Line Magnet

- Transmission Line Magnet Parameters
- Basic Design Choices
- Magnet Design
- Magnet Field Quality
- Magnet Mechanical Stability
- Correctors and Lambertson Magnets
- Summary

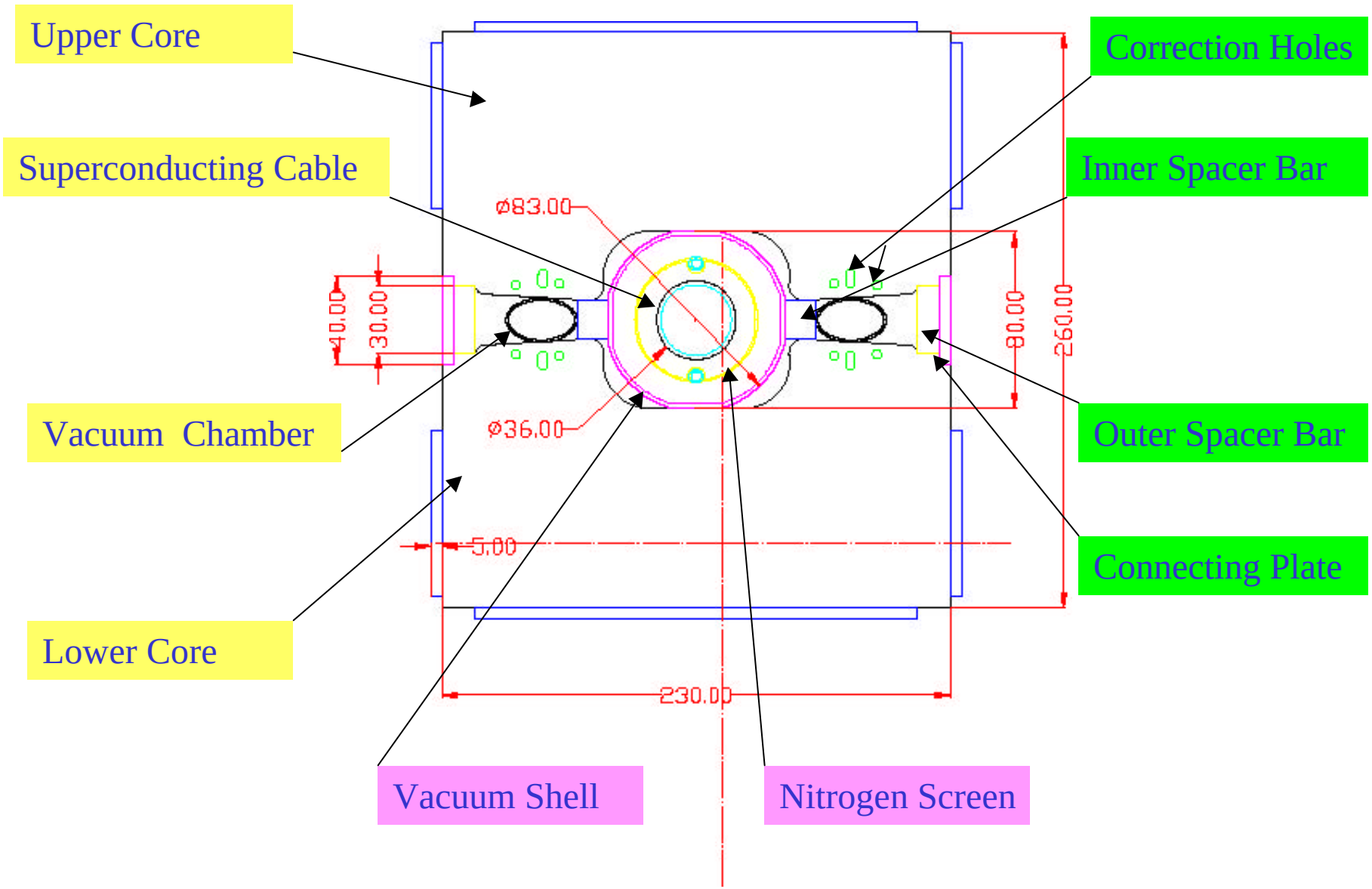
Transmission Line Magnet Parameters

Beam gaps		20 mm x 30mm
Magnet length (half-cell)		65 m
Gradient		± 3%/cm
Magnetic field: injection		0.1 T
maximum		2.0 T
Good field 0.02% area diameter :	0.1 T	20 mm
	2.0 T	10mm
Current for 2.0 T field		100 kA
Magnetic field energy		660 kJ
Inductance		0.132 mH
SC cable	16 SSC outer cables in parallel	
Peak Operating Temp.		6.5-7K
Iron Core	Low carbon Steel (AISI 1006)	

TRANSMISSION LINE MAGNET VIEW



Magnet Cross-section

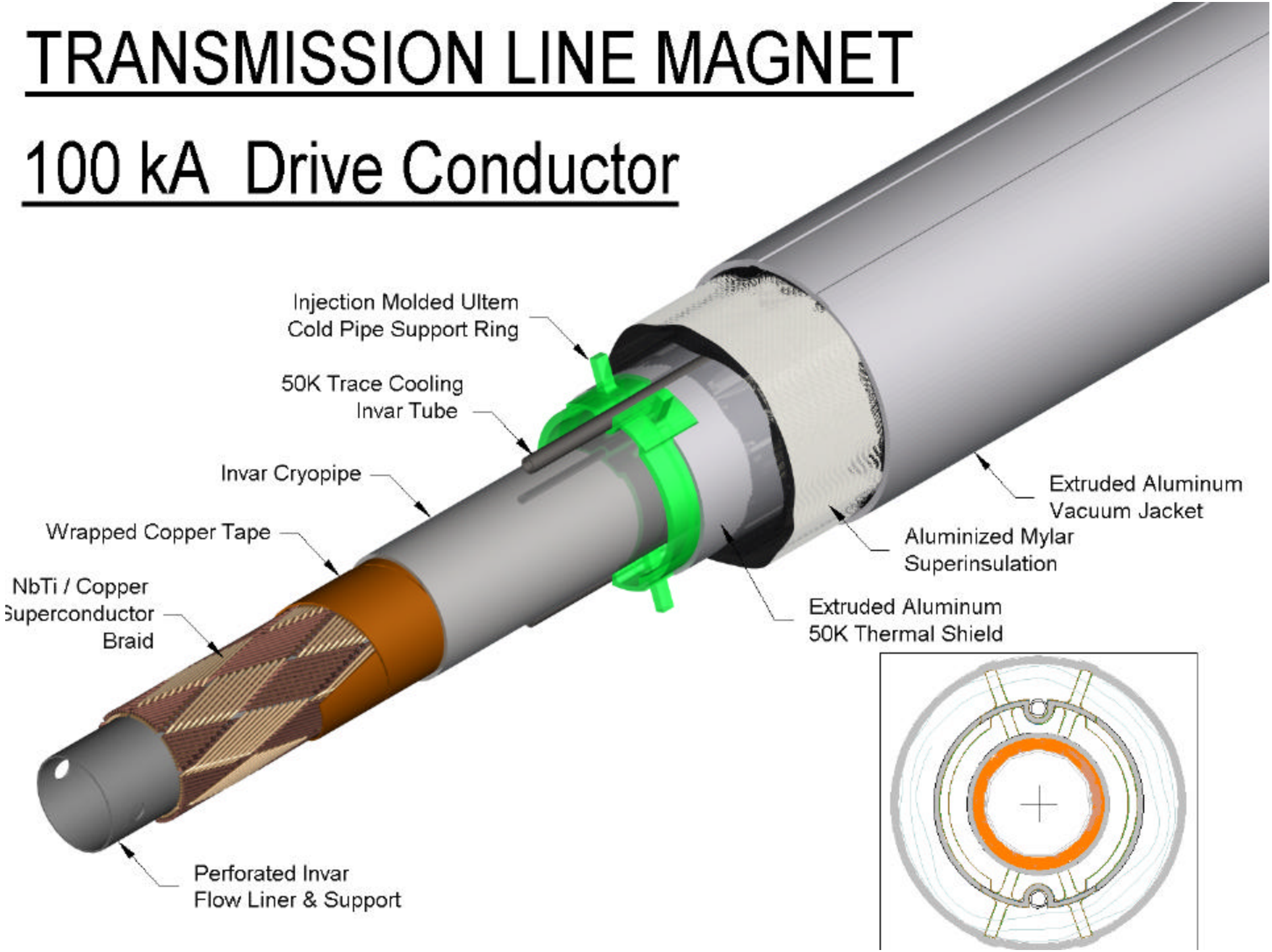


Basic Design Choices

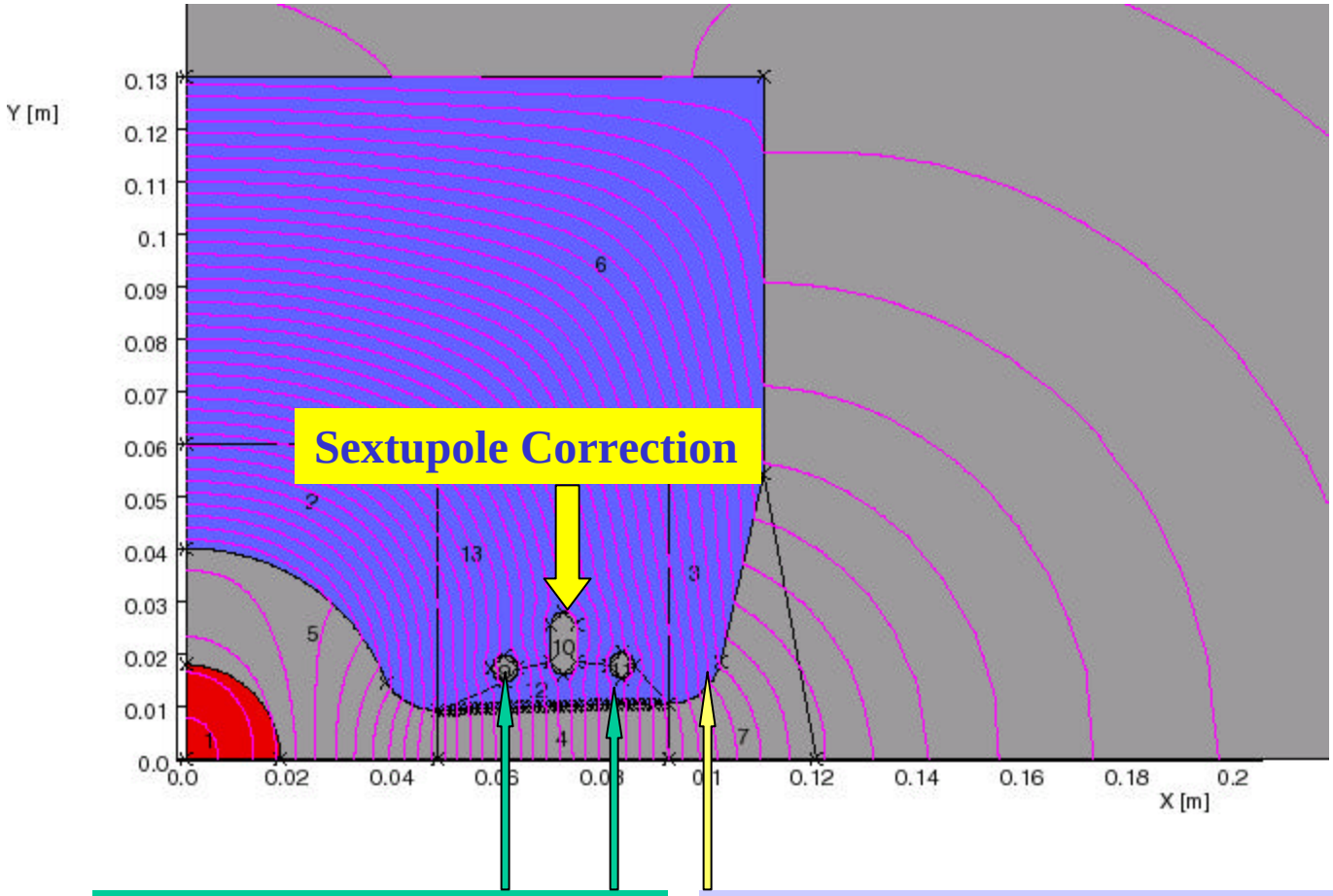
- A warm iron core and a single turn coil to simplify the cryogenic, vacuum, and quench protection systems.
- An alternating-gradient design which eliminates arc quadrupoles and allows the magnet to be continuous in long lengths.
- Magnetic field formed by iron poles with sufficient accuracy that the strong correction coils needed for conventional SC magnets would not be needed.
- Magnetic forces are reduced by position of outer conductor and lower yoke thickness.
- Superconducting transmission line conductor which can be made from available SSC outer cable.
- Low Magnet System+ Tunnel Cost per 1 TeV energy.

TRANSMISSION LINE MAGNET

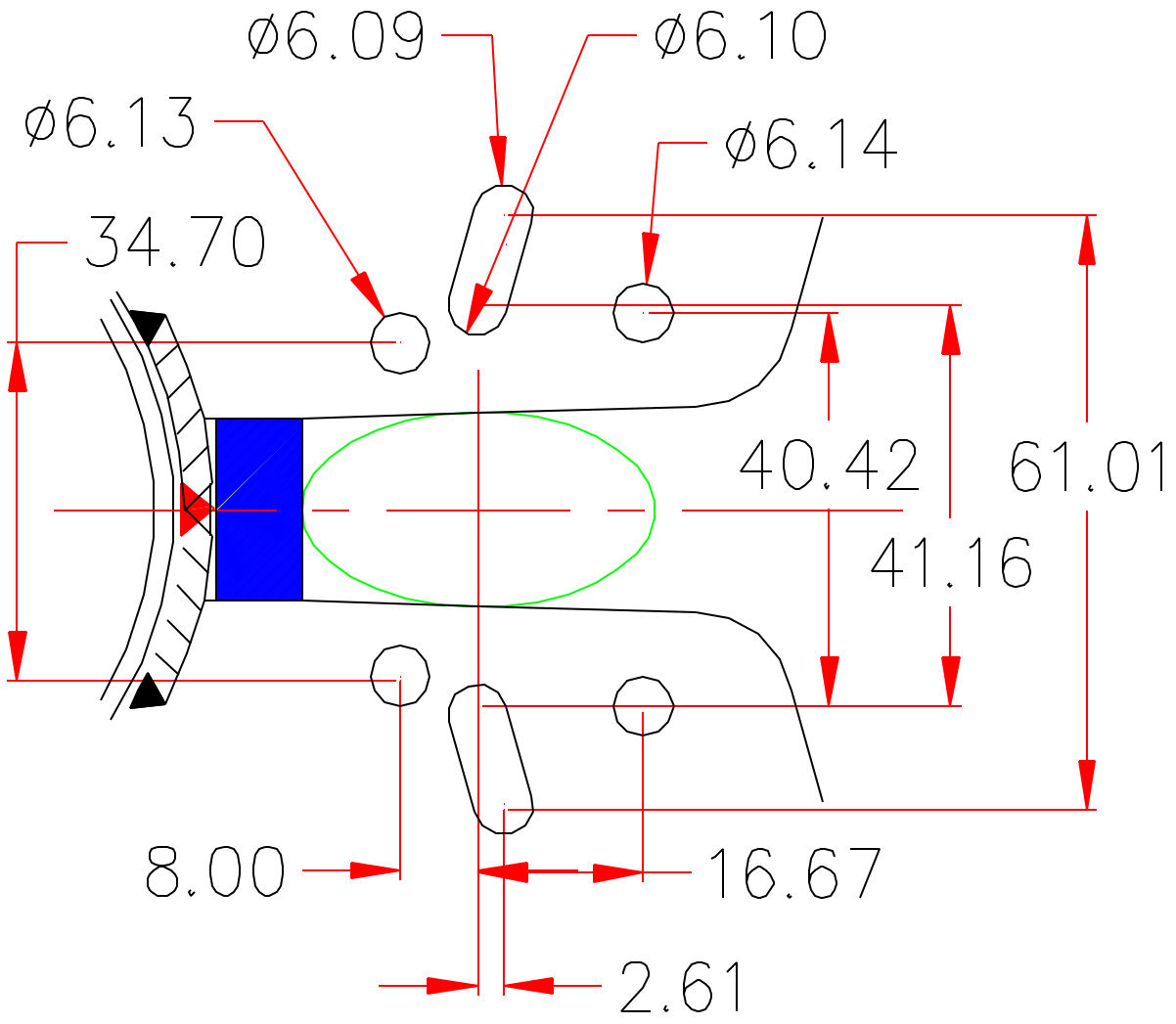
100 kA Drive Conductor



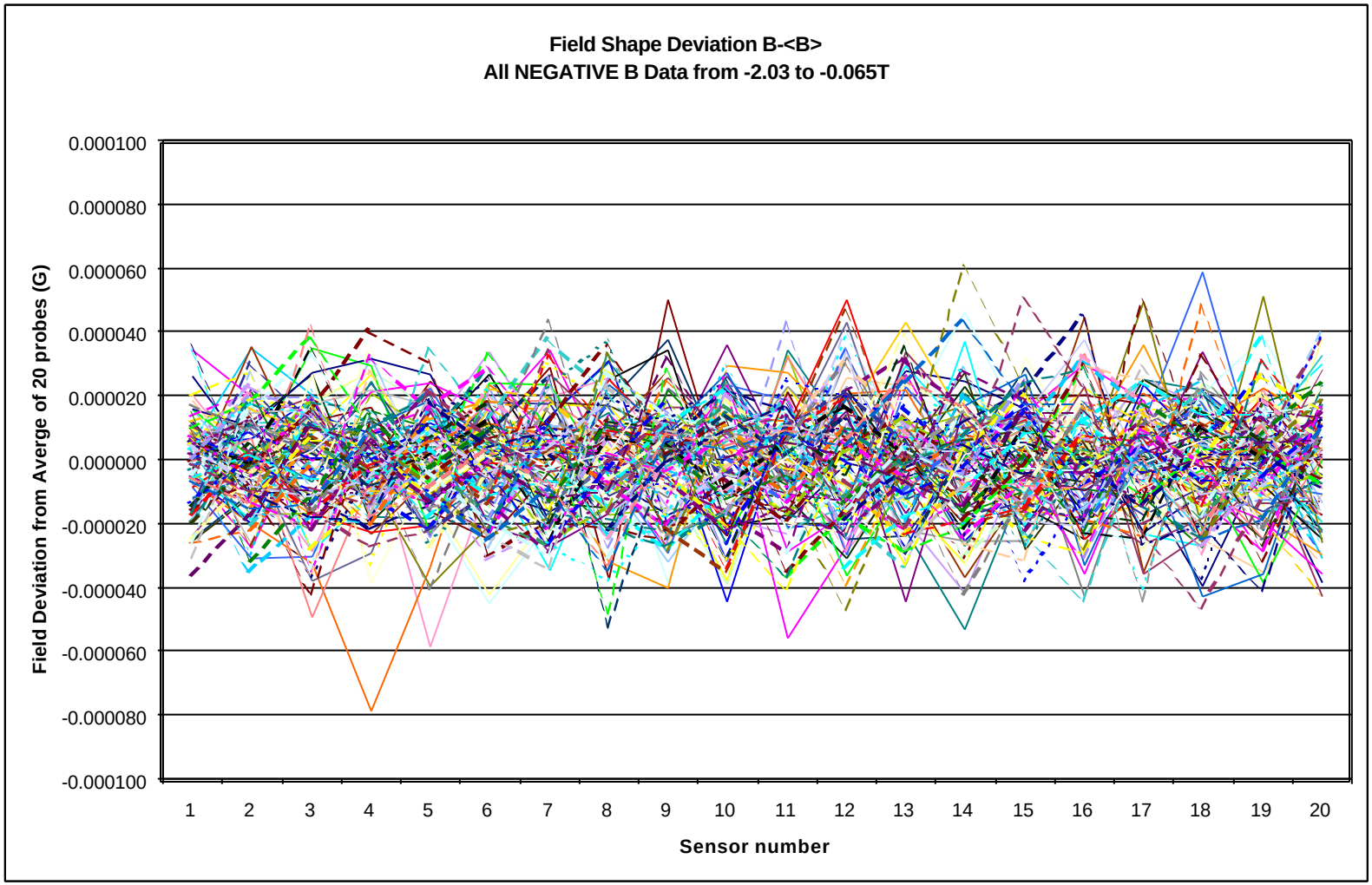
Magnetic Field Correction by Holes



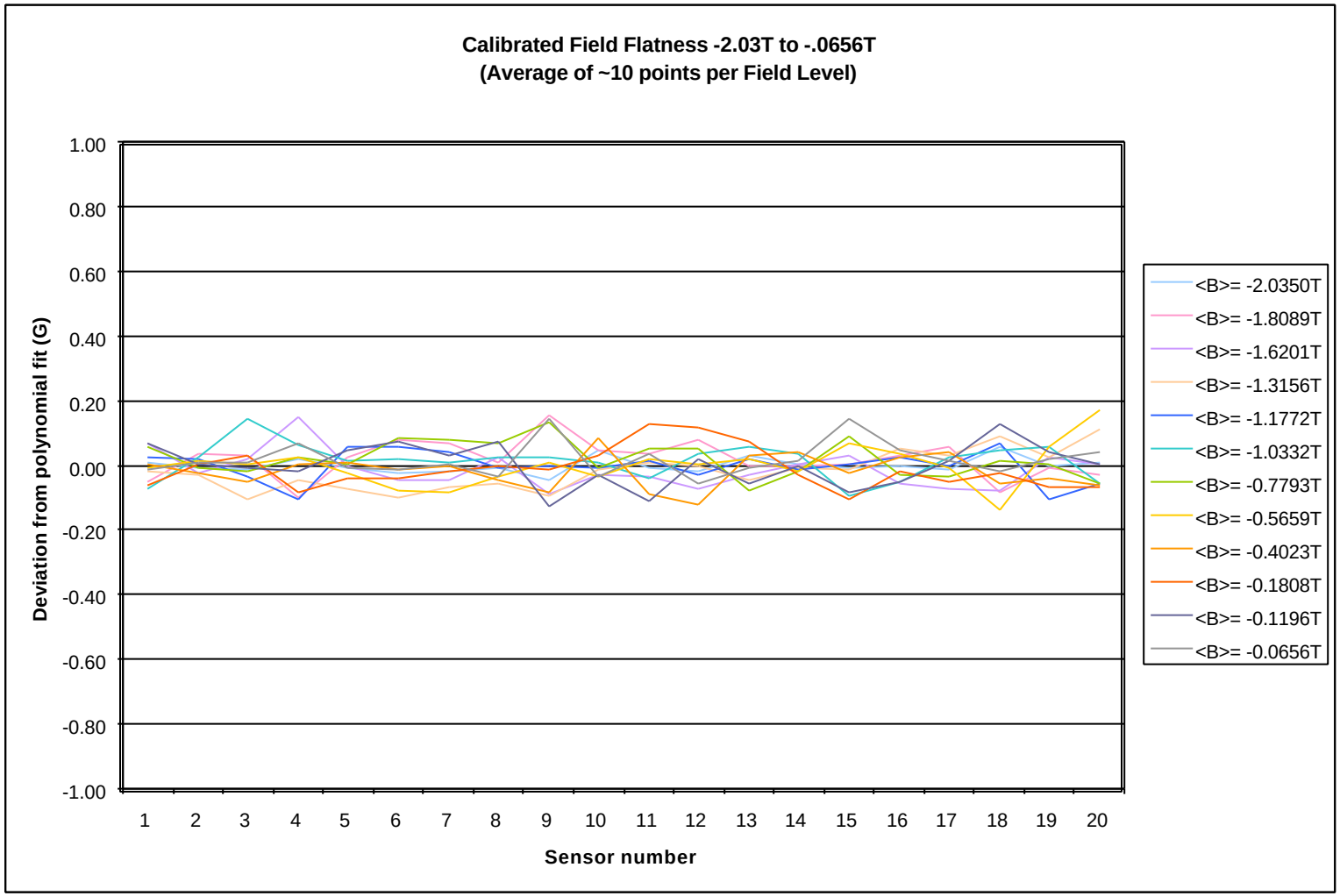
Correction Holes Position



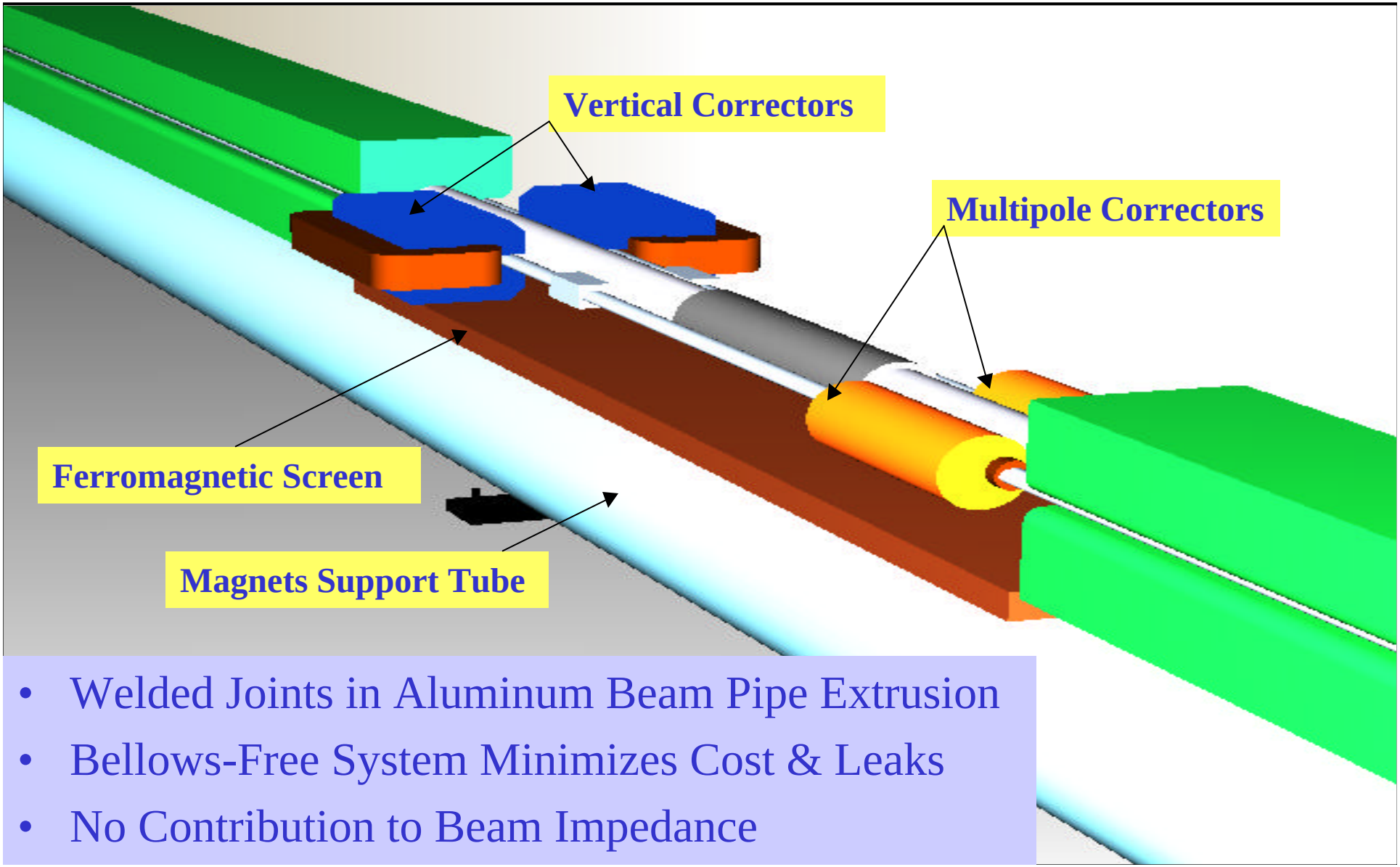
Results of 20 Hall Probe Measurements



Results of Field Averaging



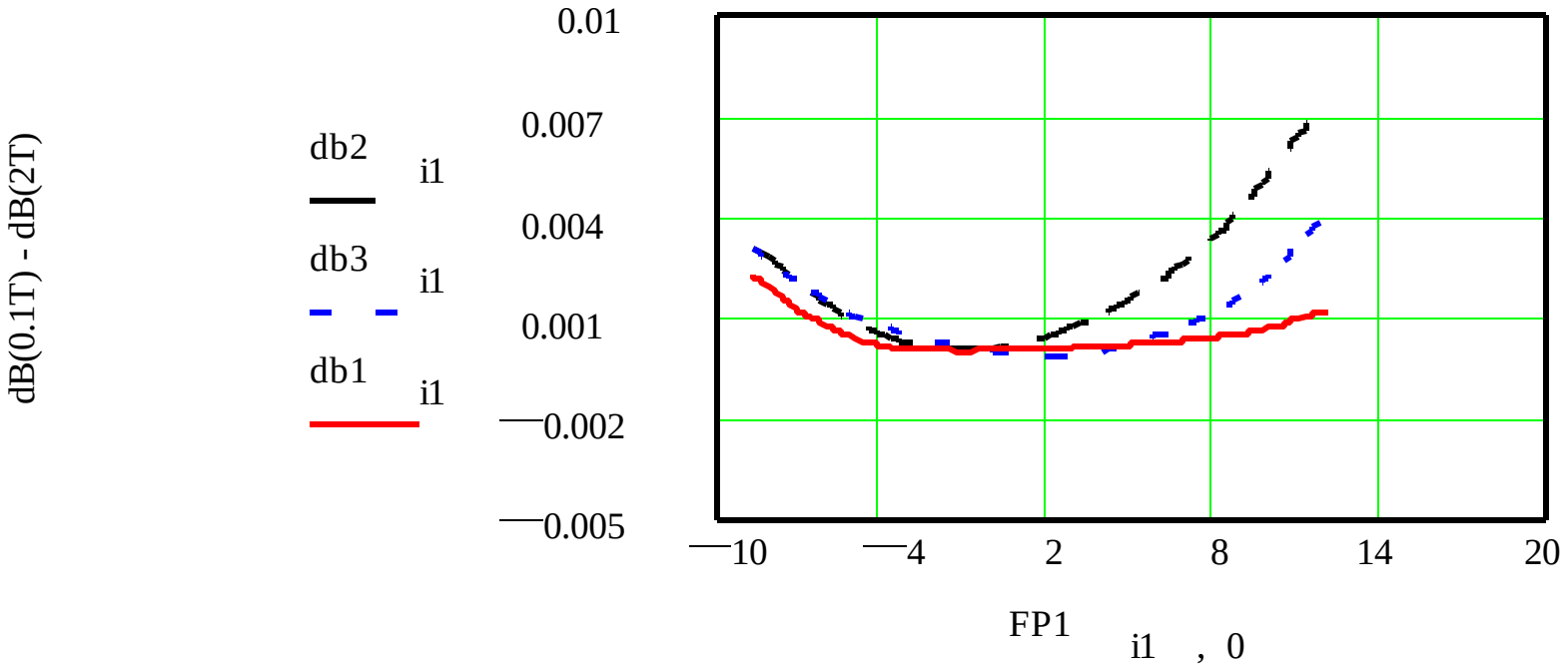
Space between Magnets



- Welded Joints in Aluminum Beam Pipe Extrusion
- Bellows-Free System Minimizes Cost & Leaks
- No Contribution to Beam Impedance

Test Stand for the Field Measurement

Results of Magnetic Measurements

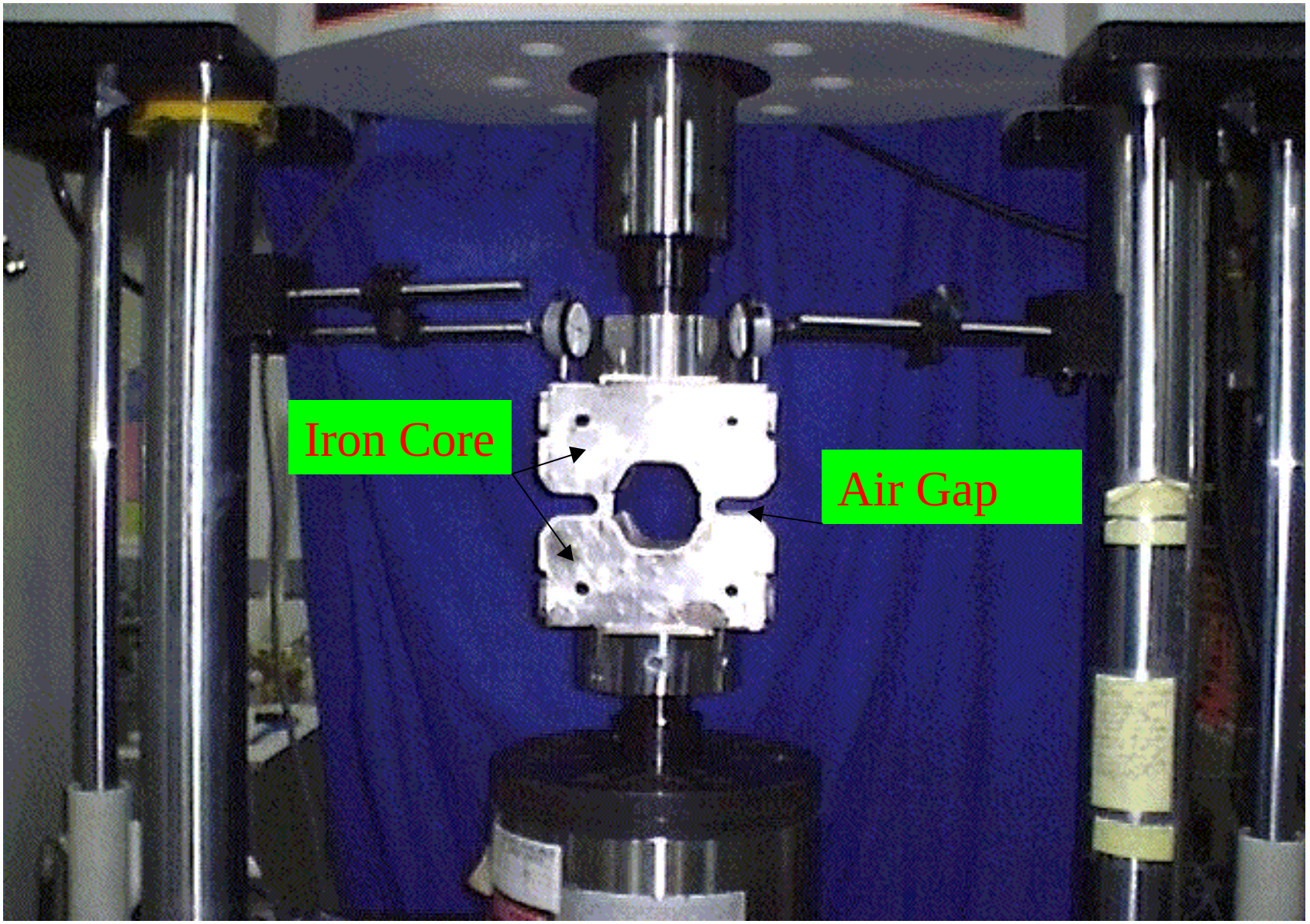


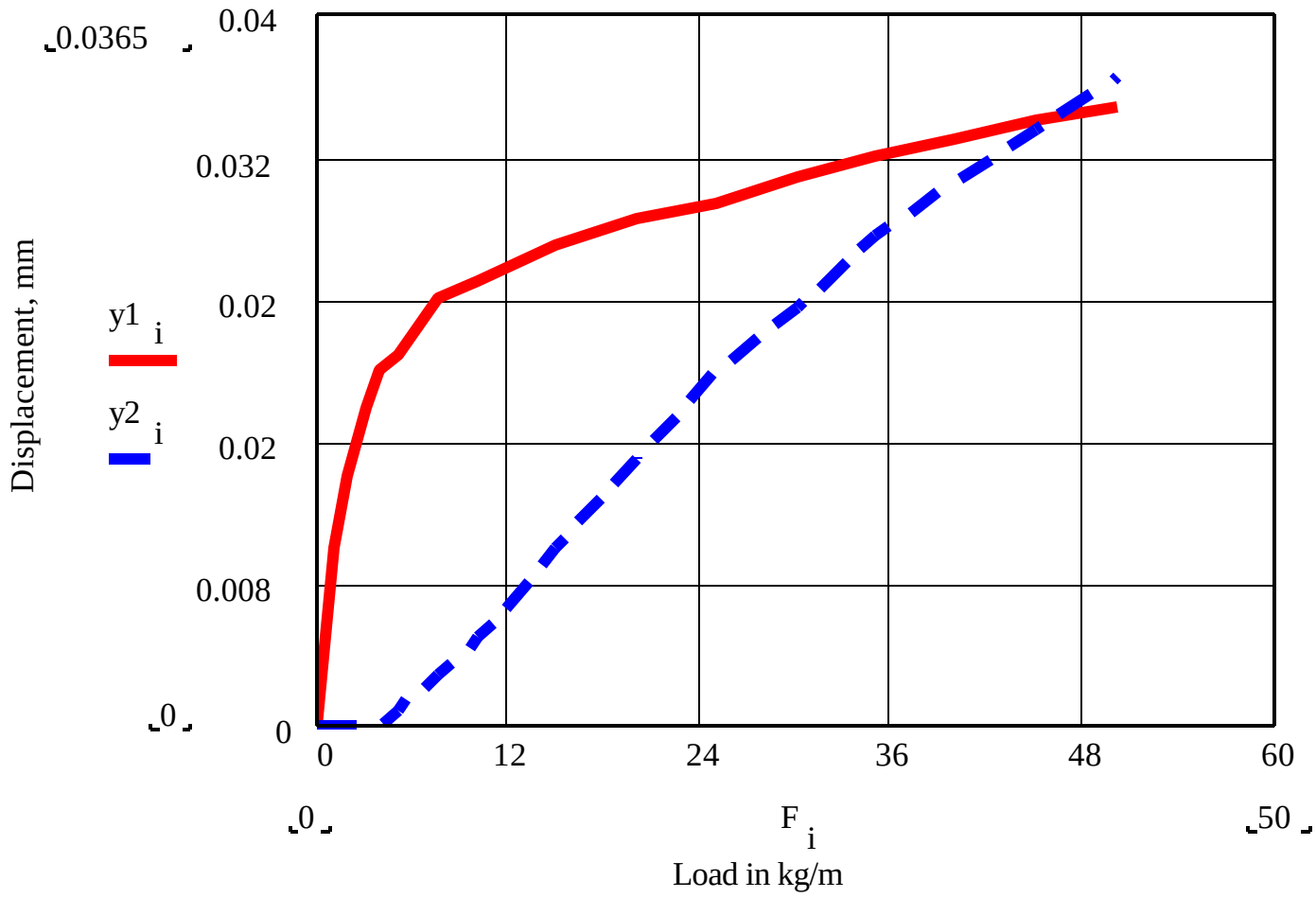
without "crenelations"

"crenenelated" withpacking factor 10%

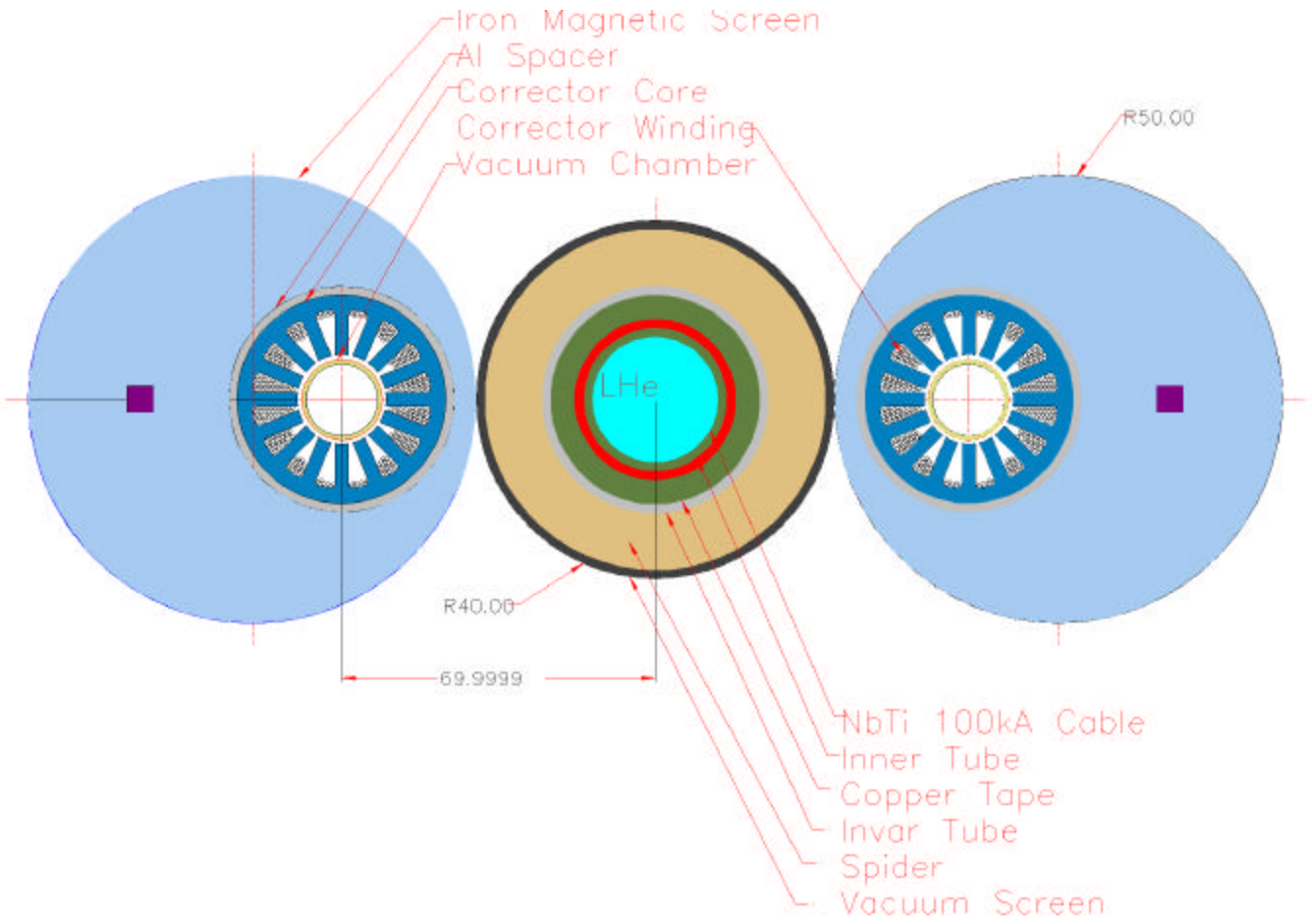
"crenelated" with packing factor 17.7%

Mechanic Model Test



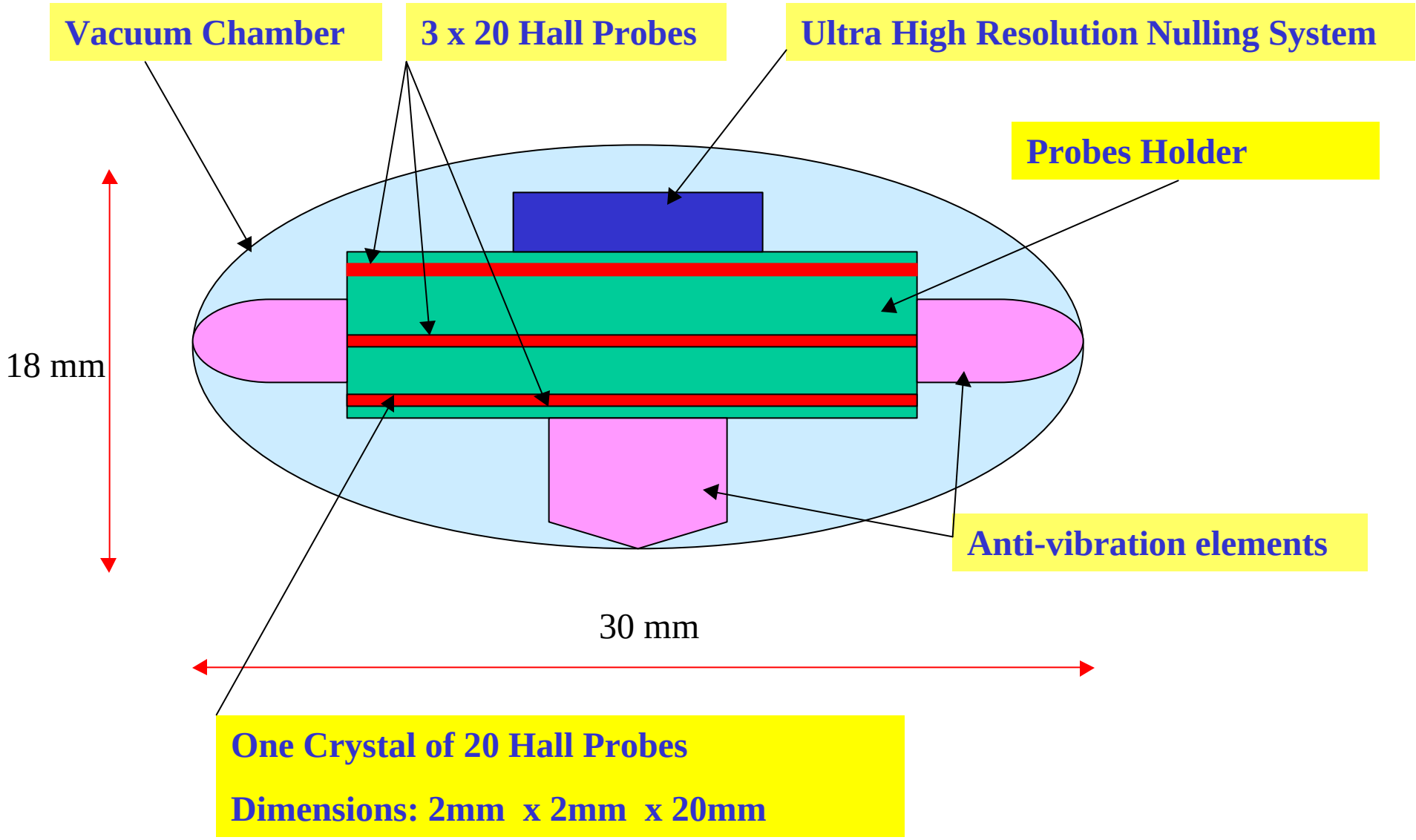

0.0365
0.04
0.032
0.02
0.02
0.008
0
0
y1 i
y2 i
Displacement, mm
0
12
24
36
48
60
0
F i
50
Load in kg/m

Multipole Corrector magnets



- Arbitrary Field Defects Corrector
- 1kG Pole tip field
- ~500W/meter dissipation
- Air Cooled
- No Cooling Water in Arcs

Concept of Hall Probes Station Moving Inside Vacuum Chamber



SUMMARY

- **The design study of the superferric VLHC main dipole is in progress at Fermilab now.**
- **Several mechanical models were investigated.**
- **Two configurations of pole profiles (conventional and crenellated) were tested.**
- **20 parallel channels Hall probes Measurement Station is in operation.**
- **Vertical and Horizontal Correctors are designed.**
- **Lambertson magnet is designed.**
- **There is a base for the long magnet manufacturing.**